



# The Presence of Green Infrastructure Among the Predominantly White Population in Houston, Texas, USA

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## Background

One location within the United States which has suffered repeated large-scale flooding, due to the overflowing of creeks and bayous, in the recent past is Houston, Texas. Exacerbating these problems is the speed at which urban sprawl is engulfing the surrounding area. A more natural solution to flood management is the implementation of Green Infrastructures (GI). These features allow for more precipitation and stormwater to evaporate or be absorbed into the ground than impervious surfaces, such as roads, parking lots, and roofs, which commonly help to move the water downstream in the watershed more quickly (Mays & Tung, 1992). GIs work to slow the overland flow of water using vegetation ditches and waterways or harness evaporation and evapotranspiration (Zellner, Massey, Minor & Gonzalez-Meler, 2016). This research investigates the occurrence of GI within three school districts in the Houston-Galveston metropolitan area: Aldine, Clear Creek, and Spring Branch Independent School Districts (ISDs). Previous studies report that ethnic composition is tied to the number of green infrastructures within an area (McCracken, Kawakami, & Egelston, 2019). Furthermore, Digital Elevation Model (DEM) data is used to interpret the influence elevation may play on the location and occurrence of GIs, as well as the average date of development of the area. As the population of Houston has exponentially increased, more urban development has occurred, and impervious surfaces contribute to high flood occurrences in the area (Khan, 2005).

## Hypothesis

This study seeks to confirm the hypothesis that the older the date of development for an area, the more GIs will be in place, due to increased pressure on outdated stormwater systems. Additionally, more GIs will be in place in areas of higher elevation as a way to mitigate stormwater runoff to areas of lower elevation, which flood regularly.

## Study Area

The study area consists of three school districts within the Houston-Galveston metropolitan area. Aldine ISD is to the north of downtown Houston, while Spring Branch is to the east of Houston proper. Clear Creek ISD is located between downtown Houston and the coastal city of Galveston.



Figure 1. Houston Galveston Metropolitan Area in Texas. Adapted from McCracken, Kawakami, & Egelston, 2019.

## Methods

- Data regarding the location of Green Infrastructure (GI) was developed using Google Earth's street view function. In using this method, we were only able to identify GI that consisted of bioswales, infiltration basins, retention ponds, detention ponds, and wetland channels, as described by the Environmental Protection Agency and American Society of Civil Engineers (2002). The location of these features was then marked in Google Earth.
- After moving the GI locations from Google Earth into the ArcGIS suite, school district location data was added from the Houston-Galveston Area Council (HGAC) database. The number of GI in each school district can be seen in Figure 2 and Table 1.
- A second dataset from HGAC was used to evaluate elevation within each school district. This dataset utilized Digital Elevation Model (DEM) data from USGS. Using the Raster Calculator function, analysis determined the number of cells that represented each elevation. This was then averaged in Microsoft Excel to determine the percentage of area covered by specific elevations. Figure 3 indicates the elevation change throughout the school districts and Table 2 displays the percentage of specific elevation levels within each district.
- The data concerning the development of the area was taken from Harris County Appraisal District and the Galveston County Appraisal District. Using Microsoft Excel, this data was then averaged in order to provide us with the average year of development for each study area. These numbers can be seen in Table 3.
- The ethnicity data was taken from the National Center for Education Statistics website. This data is representative of the ethnic composition of each school district from 2013 to 2017 and is displayed in Table 4.

## Results

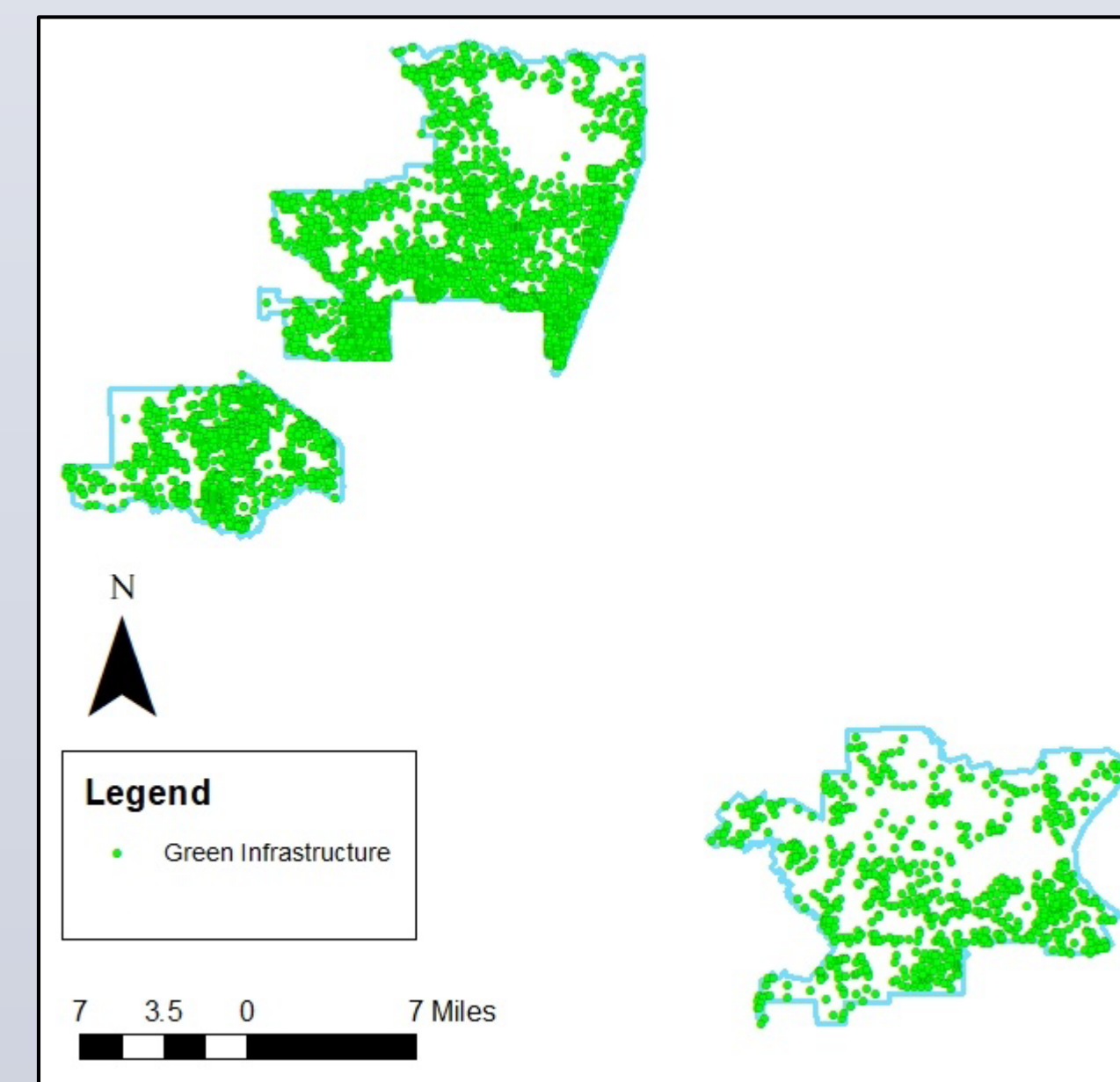


Figure 2. Green Infrastructures in locations. Adapted from McCracken, Kawakami, & Egelston, 2019.

Total GIs	Aldine ISD	Clear Creek ISD	Spring Branch ISD
Total GIs	2115	765	1182
Total Area of District in mi <sup>2</sup>	109	105	41
GI per mi <sup>2</sup>	19.4	7.3	28.8

Note: This table displays the number of GI in each school district, the size of the districts, and the number of GI per mile in each district. Adapted from McCracken, Kawakami, & Egelston, 2019.

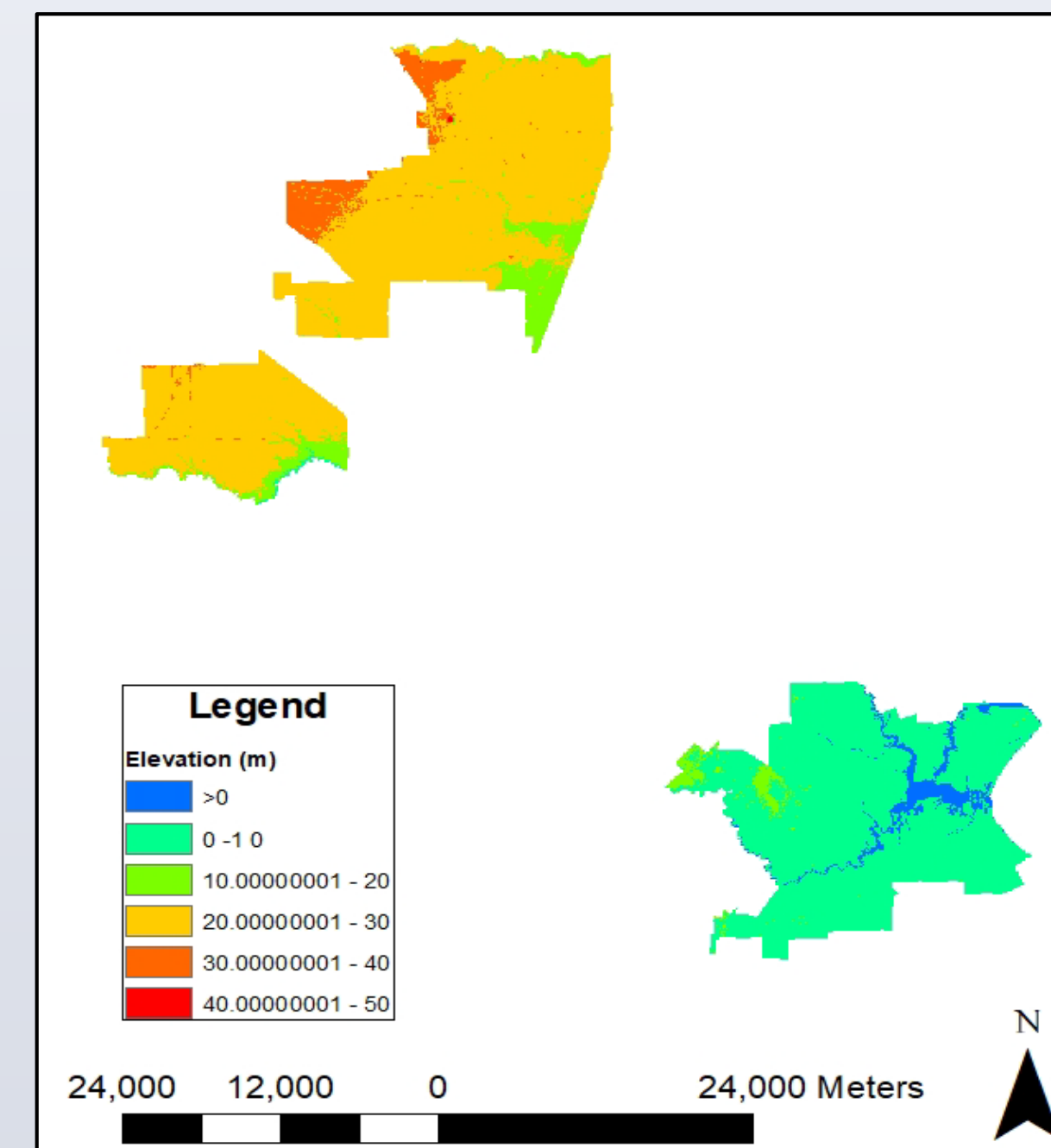


Figure 3. Elevation data for the school districts, represented in meters.

Elevation (m)	Aldine ISD		Clear Creek ISD		Spring Branch ISD	
	Count	Percentages	Count	Percentages	Count	Percentages
<0	0	0.000	214805	62.072	0	0.000
0-10	64	0.002	2558921	73.945	5639	5.160
11-20	414166	14.268	95869	2.770	201150	18.409
21-30	2357447	81.219	214805	6.207	881262	80.654
31-40	129513	4.462	214805	6.207	4597	0.421
41-50	1383	0.047	161365	4.663	0	0.000

Note: This table displays the cell counts for elevations and the percentage of the school district covered by that specific range of elevation levels.

## Table 3. Average Date of Development

School District	Average Date of Development
Aldine ISD	1977
Clear Creek ISD	1989
Spring Branch ISD	1947

Note: This table displays the average date of development within Aldine, Clear Creek, and Spring Branch ISDs. (Harris County Appraisal District, 2019; Galveston County Appraisal District, 2019).

## Table 4. Ethnic composition

School District	% White	% Black	% Hispanic or Latino	% Asian	% Two or more races and others
Aldine	9	26	62	2	1
Clear Creek	61	8	20	9	3
Spring Branch	43	4	44	7	1

Note: This table displays the percentage of different ethnicities found in Aldine, Clear Creek, and Spring Branch ISDs. Adapted from McCracken, Kawakami, & Egelston, 2019.

## Discussion

Previous studies determined that in the case of Aldine, Clear Creek, and Spring Branch ISDs that no direct correlation exists regarding the presence of GI and poverty levels or educational attainment (McCracken, Kawakami, & Egelston, 2019). However, that study did determine that a higher number of GI occur in predominantly Hispanic school districts.

Our study looked to investigate the relationship between lower numbers of GI in areas of white majority. While Clear Creek ISD has the higher percentage of white residents, previous studies have indicated that GIs located at higher elevations, upslope to areas highly prone to flooding, provide more flood protection (Fry & Maxwell, 2017). Our data aligns with this by showing higher elevations of between 20-30 meters in Aldine and Spring Branch ISDs having significantly more GIs than Clear Creek ISD.

In addition, the average date of development for each school district brings forth an interesting pattern. The Spring Branch ISD area was developed around 1947. Mieszkowski & Smith (1991) reveals that spacious lots on the western side of Houston were indicative of the upscale neighborhoods that developed around the 1940's and 1950's and have seen few modifications since. As the city continued to rapid expansion developments began moving into the suburbs instead of redeveloping inner-city and downtown areas. This results in the average development date for Aldine ISD being 1977. Clear Creek ISD straddles the Harris-Galveston County boundary with the average development date here being 1989. This area is less developed than the previously discussed ISDs with more wetlands, meaning more natural flood protection and less need for human influenced GIs (Reja, Brody, Highfield, & Newman, 2017).

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## Acknowledgements

I would like to thank the following for their help and support of this project:

College of Science and Technology, Tarleton State University  
Department of Chemistry, Geosciences, and Physics, TSU  
Center for Environmental Studies, TSU  
Dr. Atsuko Kawakami  
Dr. Opeyemi Zubair

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